Growth and Year-class Success of Yellow Perch Following Impoundment

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Abstract: Population dynamics of yellow perch, *Perca flavescens* Mitchill, were examined during the initial 7 years of impoundment of West Point Lake (1975–1981). Preimpoundment lengths of yellow perch at successive ages for the 1972 to 1974 year classes were greater than lengths at successive ages for the 1976 to 1981 year classes. The 1975 year class was intermediate to those before and after impoundment. Yellow perch reached maturity in 2 years, and the number of young-of-the-year (YOY) was highly correlated ($r = 0.99$; $P < 0.05$) to the number of YOY 2 years earlier. There was no correlation of YOY numbers ($r = 0.04$; $P > 0.05$) and weak correlation of standing stock ($r = 0.40$; $P < 0.05$) to days of spring and summer flooding.

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The yellow perch population in West Point Lake is the southernmost population for which its life history has been studied. Its distribution ranges from northern Canada south to the Ohio River bordering Kentucky and south along the Atlantic Coast into South Carolina (Lee 1980). Yellow perch are not considered native to Alabama or Georgia (Dahlberg and Scott 1971, Jenkins et al. 1971). Earlier studies in West Point Lake examined the food habits of yellow perch (Timmons 1984*b*) and compared the early life histories of yellow perch and largemouth bass, *Micropterus salmoides* (Timmons 1984*a*). Yellow perch were segregated from largemouth bass both spatially and by food choice. Availability of fish as prey appeared to limit growth of older yellow perch. Warm (≥30° C) littoral areas in summer may separate yellow perch in deep thermal refugia from prey fishes in littoral areas.

The objectives of this study were to examine growth and year class strengths among year classes and observe changes during the initial 7 years after impoundment. The effects of strong year classes on subsequent year classes and the effects of fluctuating water levels were also examined.

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Methods

West Point Lake, a U.S. Army Corps of Engineers impoundment of the Chattahoochee River, extends from 5.1 km north of West Point, Georgia (near the Alabama state line), to Franklin, Georgia. It lies above the fall line in the Piedmont physiographic region. It was impounded in October 1974 and filled to full pool by May 1975. The lake is maintained at 194 m above mean sea level, except in winter when it is drawn down 3 m for flood control. At the summer pool elevation, the surface area is 10,500 ha, the shoreline length is 850 km, and the mean depth is 7.1 m.

The lake is stratified in summer and may have areas below 24 m with <1 ppm dissolved oxygen. Inflowing water of the Chattahoochee River always exceeded 5 ppm dissolved oxygen (Davies et al. 1979). Water temperatures during summer ranged from 35° C on the surface to 21° C below 24 m.

Yellow perch were collected from 1975 through 1981 with gill nets, by electrofishing bimonthly, and in summer by seining and from large coves poisoned with rotenone. Ninety to 125 collections were made annually from May to September 1977 to 1981 by poisoning fish with rotenone in littoral areas as described by Timmons et al. (1978). Four coves of 0.5 to 2.0 ha were sampled in August of each year with rotenone to estimate the number and weight per hectare of fish. Yellow perch were measured to the nearest millimeter in total length and weighed to the nearest 0.1 g. Scales were removed above the lateral line from the area above the pectoral fin. Sex and sexual maturity was determined by examining the gonads. Yellow perch in the Auburn University Ichthyological Collection were weighed, measured, and their scales examined to determine preimpoundment growth rates.

Population size, standing stock, and instantaneous mortality rates (Z) for year classes were calculated from numbers of fish remaining from year to year in August rotenone samples. The slope of the regression of the natural logarithm of number of fish per hectare on time was used to estimate Z (Ricker 1975); Z was also calculated for the time interval (t) between the large cove samples from the equation: $Z = (\ln N_0 - \ln N_t)/t$, where N_0 is the initial number of fish, and N_t is the number remaining at time t (Ricker 1975). The Lee method of correcting for the intercept of the body length-scale radius relation was used to back-calculate mean lengths attained at successive annuli.

Daily water levels were obtained from monthly operating charts provided by the U.S. Army Corps of Engineers. Flooding was quantified as hectare-days of flooding where 1 hectare-day of flooding was a hectare of the flood pool inundated for 1 day. The number of hectare-days of flooding was calculated for the period from mid–April through August from 1977 to 1981 by Miranda et al. (1984).

Results

Yellow perch annulus formation coincided with the end of the spawning season in late April at West Point Lake. Verification of the scale method for aging yellow perch was possible by a number of methods. Length-frequency distributions corroborated the aging techniques for the first 4 years. Back-calculations for early annuli coincided with actual lengths of young fish. And finally, abundant and scarce year classes were consistently evident in successive yearly collections. The sexes were combined because there was no significant difference ($P > 0.05$) between lengths of males and females. The ratio of females to males in the samples was 1:2.3 for fish >70 mm.

Linear regressions of total body length on scale radius were calculated for the total number of fish and by year class. Young-of-the-year (YOY) as small as 21 mm were included for each year class beginning in 1977. The intercept, 38.0 for all fish ($N = 2{,}062$, $r = 0.938$), was used for all back calculations.

Preimpoundment lengths of yellow perch at successive ages for the 1972 to 1974 year classes were greater than lengths at successive ages for the 1976 to 1981 year class (Fig. 1). During the first 3 years the 1975 year class was intermediate to those before and after impoundment but showed only a small increase in length afterwards. Yellow perch from the preimpoundment samples grew an average of 150 mm during the first year, while yellow perch reached 115 to 120 mm during their first year from 1976 to 1979. The maximum length for older age groups approximated 170 mm after impoundment; before impoundment length of older yellow perch averaged 230 mm.

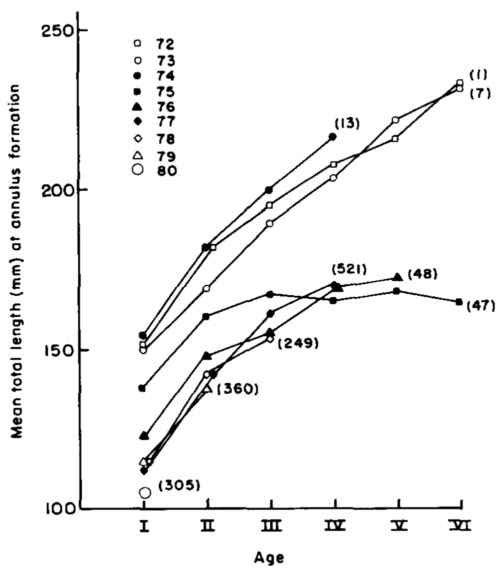

Figure 1. Back-calculated mean total length of yellow perch at each age of life for each year class (1972–1980) from West Point Lake (number of fish in parentheses).

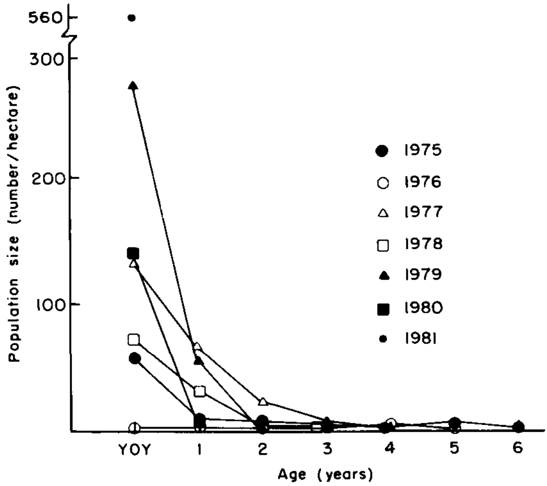

Figure 2. Abundance in August cove rotenone samples for young-of-the-year (YOY) and age classes 1 to 6 of yellow perch from 1975 to 1981 at West Point Lake.

Year class strength, as measured by number of YOY per hectare, increased from 1975 (58) to 1981 (560). In 1976, few mature yellow perch remained from the preimpoundment population, and the fish of the initial year class were immature. This resulted in a mean of only 2 YOY per hectare. By Age I, each year class had less than 70 yellow perch per hectare in August (Fig. 2).

The greatest rate of first year survival (actually 0+ to I+, August to August) was for the 1977 year class (47.7%), followed by: 1978 (45.7%), 1979 (21.7%), 1975 (15.5%), and 1980 (5.2%). Survival to Age II+ in August was highest for the 1977 year class (16.6% versus 13.8% for the 1975 year class, 5.7% for the 1978, and 0.7% for the 1979). Fish from both the 1975 and 1976 year classes were poorly represented by collections in 1976. The instantaneous rate of mortality (Z) decreased from the 1975 year class to the 1979 (Table 1).

The number of young and adult yellow perch decreased the second year after impoundment, then increased until the fifth year, when it declined but increased again in the seventh year (Fig. 3). The number of YOY was highly correlated to the number of YOY 2 years before ($r = 0.99$). Yellow perch from West Point Lake matured and spawned after 2 years. Few YOY were collected the second year of impoundment. Fish from the initial year class were too small to spawn in the second year and the number of adults present from the river population was low by 1976.

The number of YOY was compared to the number of hectare-days of flooding at West Point Lake. There was no significant correlation of yellow perch numbers ($r = 0.04$, $P > 0.05$) and biomass ($r = 0.40$; $P > 0.05$) to days of flooding. Flooding affected density in shallow coves like Yellowjacket Creek cove more than deep coves like Wehadkee Creek cove (Table 2), but overall did not affect population numbers. Low water levels greatly reduced the surface area of some shallow coves like Yellowjacket Creek cove.

Table 1. Number/hectare of young-of-the-year (YOY) through Age 6, instantaneous rate of mortality (z), and correlation coefficient (*r*) as calculated from weighted means of 4 coves sampled each August at West Point Lake.

Year class	YOY (No.)	Age 1	2	3	4	5	6	Z	*r*
1975	58	9	8	4	1	7	1	1.24	−0.81
1976	2		1	1	3	1			
1977	132	63	22	5	1			0.66	−0.81
1978	70	32	4	1				0.65	−0.98
1979	272	59	2					0.39	−0.97

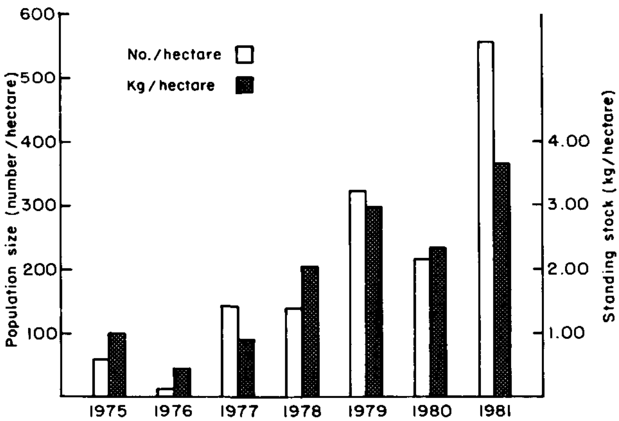

Figure 3. Abundance and standing stock of yellow perch in August at West Point Lake (1975–1981).

Table 2. Relationship of days of flooding (mid-April to August) to density or biomass of young-of-the-year (YOY) yellow perch in West Point Lake. Correlation coefficients (*r*) are for the regression of density or biomass in August on hectare-days of flooding.

Year	1977	1978	1979	1980	1981	*r*
Hectare-days of flooding	2,935	29,081	45,575	29,549	13,702	
Density (*N*/ha)						
All coves (weighted mean)	132	70	272	135	422	−0.04
Yellowjacket Creek cove	167	63	123	1,245	424	−0.47
Wehadkee Creek cove	75	86	242	145	758	−0.17
Biomass (kg/ha)						
All coves (weighted mean)	0.51	0.30	1.37	1.15	1.28	0.40
Yellowjacket Creek cove	1.11	0.46	1.32	1.23	1.79	−0.16
Wehadkee Creek cove	0.56	0.70	1.27	1.39	1.68	0.28

The estimated standing stock of yellow perch fluctuated as did the numbers until it reached a peak in 1981 of 3.6 kg/ha (Fig. 3). The proportion of the total standing stock for all species represented by yellow perch increased from 1975 to 1981. Yellow perch represented 0.25% in 1975, decreased slightly in 1976 and 1977, increased to 0.75% in 1978, leveled off during 1979 and 1980, and increased to 3.80% in 1981.

Discussion

It is not clear why yellow perch of the 1975 year class grew poorly after 1977 while fish still present from the 1973 year class were growing well in 1977 and 1978 in West Point Lake. In 4 Missouri River reservoirs, growth was most rapid for all year classes of yellow perch during the early years of filling than after reaching full pool (Nelson and Walburg 1977). Growth of fish from the 1975 year class slowed after they reached 165 mm. The predominant food item for yellow perch >150 mm was dipteran larvae, except in summer when young of the year of bluegill (*Lepomis macrochirus*) and threadfin shad (*Dorosoma petenense*) were available (Timmons 1984*b*). YOY threadfin shad are limnetic year long and by fall were too large to serve as prey for yellow perch. YOY bluegill are limnetic until they achieve a size of 22 to 25 mm and then they return to the littoral zone (Werner 1969). Yellow perch may have been restricted to deep cool water in the summer in West Point Reservoir. Temperatures of 32° to 35° C were observed in littoral waters in July and August. A similar situation occurred in Lake West Okoboji, Iowa, where yellow perch consumed chironomid larvae in deep waters when restricted by high littoral temperatures, although in years when they could inhabit shallow waters, fish were an important food (Bardach 1955). Perch in other lakes without high littoral water temperatures have also been observed to inhabit shallow water during the spring and summer and congregate in deep water in the fall and winter (Kipling and Le-Cren 1984). A continued macroinvertebrate feeding stage instead of switching to a fish diet has been viewed as a potential "bottleneck" in the growth of perch populations (Alm 1946, Keast 1977, Persson 1986). Limnetic prey fishes in West Point Lake may have only been available as prey to larger yellow perch in the summer.

More male yellow perch were collected than females. Spatial separation of the sexes, with females most abundant in shallow areas and males in deeper waters, has been observed in Lake Erie (Jobes 1952), Lake Michigan (Wells and Jorgenson 1983), and Lake West Okoboji (Sandheinrich and Hubert 1984). Aggregates of females may have been missed in West Point Lake, although it seems that bias would have been for females in littoral areas sampled by electrofishing and seine.

Measuring year class strength for yellow perch young of the year from large coves poisoned with rotenone appeared to be a valid method. Strong year classes could be followed from year to year by their abundance in successive summer samples. In 1975 there was good production of YOY, even though the number of mature yellow perch was probably low. When the river was impounded there was a vast area for fish population expansion. The smallest year class was produced in 1976. Yellow perch from the initial year class (1975) were immature and the number of preimpoundment spawners may have been reduced by natural mortality. Year-class strength was highly correlated to the number of YOY 2 years before. Yellow perch from West Point Lake matured and spawned after 2 years. El-Zarka (1959) found that year-class strength of yellow perch in Saginaw Bay was correlated with production 4, 5, and 6 years later. Growth was slow in Saginaw Bay, and females usually matured at Age 4. Year-class strength has also been correlated to the amount of newly inundated terrestrial vegetation (Nelson and Walburg 1977) and temperature, with above average temperatures reducing year-class numbers (Craig et al. 1979).

There was no significant correlation of YOY yellow perch numbers or biomass to hectare-days of flooding in West Point Lake. El-Zarka (1959) also found no correlation of year-class strength to water level in Saginaw Bay. A direct relation was observed between water levels in spring and early summer and the numbers of YOY yellow perch in summer catches in Lake Francis Case, South Dakota (Gasaway 1970, Walburg 1977, Martin et al. 1981). Flooding enhanced spawning success by providing a more suitable substrate and protective cover for early life stages. The amount of newly inundated terrestrial vegetation and the change in water levels during spawning accounted for 79% of the fluctuation in strength of year classes established in Lake Oahe (Nelson and Walburg 1977). The amount of newly flooded vegetation was the most important factor. Conditions were different in West Point Lake than Missouri River impoundments because West Point Lake filled to full pool during the first spring it was impounded. Abundance of yellow perch in Lake Oahe, South Dakota, was highest during the 9 years when the reservoir was filling and declined after reaching full pool (June 1976, Nelson 1978). Reduction and degradation of the littoral spawning and nursery habitats were probably responsible for the decline in abundance after filling of the reservoir in June 1976.

Management Implications

Stunting and over-population of yellow perch populations have created problems in some southeastern lakes (Dahlberg and Scott 1971). Yellow perch in West Point Lake did not develop into a fishery, and there was no evidence they were important as prey. Because introductions of yellow perch are usually detrimental or of little value to existing fisheries in the southeastern United States, additional stockings should cease.

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